Using information and communication technology (ICT) in tomorrow's universities and using assessment as a tool for learning by means of ICT

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Introduction

The 1999 National Survey of Information Technology in Higher Education ([1], p. 1) states: "Assisting faculty efforts 'to integrate technology into instruction' remains the single most important information technology (IT) challenge confronting American colleges and universities over the next two to three years, according to new data from The Campus Computing Project. Fully two-fifths (39.2 percent) of the institutions participating in the Project's 1999 survey identify 'instructional integration' as their single most significant IT challenge, up from 33.2 percent in 1998 and 29.6 percent in Fall 1997."

The insights and developments presented here are intended to contribute to the search for an answer to this challenge. We will outline the changes that are being considered in learning and instruction, and their effects on student assessment. We will stress the impact of information and communication technology (ICT), and the possibilities that it offers to increase the effectiveness and efficiency of learning. The starting point will be the development of powerful learning environments and, as an integral part of it, the so-called burst of the assessment culture. Some of the trends within this development will be discussed, and the role of ICT will be highlighted. Finally, we will suggest a research agenda for the future.

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Recent developments in the learning society

There is no discussion any longer about the rapid changes within different domains in society such as medicine and business. In comparison with these domains, changes within the domain of education for a long time seemed to be less apparent. However, it seems that the learning society, as we will call the domain of education, will change more in the coming decades than it did in the past few.

Dochy [2] refers to recent developments in the learning society that are orchestrated by at least six different developments. The information age is characterized by an infinite, dynamic and changing mass of information. Information is now exchanged very rapidly and knowledge is growing at an exponential rate. There is no possibility of individual scientists possessing all the knowledge within their discipline. Scientists, now and in the future, need to master the basic knowledge of their field and the skills necessary to navigate around their discipline. This shift is also true for teachers, who have traditionally been accepted as the sources of all knowledge and experience within the educational process. The teacher now is better represented as a key to open the door to domains of knowledge and experience.

As we enter a new era of technological possibilities, education will use IT in all its forms. This is supported by the results of the 1999 National Survey of Information Technology in Higher Education [1]. More college courses seem to use more technology resources than before. Electronic forms of communication are already used intensively in academic contexts. The use of multimedia, local networks, shared communication systems, the Internet, shared electronic databases, video conferencing facilities, electronic self-study materials, study support and guidance through networks, progress assessment systems, intake and monitoring systems, and so on, will enhance the development of new teaching and learning strategies. Green ([3], p. 2) observes that "despite some dire predictions on both sides of the issue, the real future of technology in higher education is not about a winner-take-all competition between high touch and high tech. Rather, what's ahead for most faculty and most students is some kind of hybrid learning experience in which technology supplements, not supplants, both the content and the discourse that have been part of the traditional experience of going to college."

As the use of IT increases, the world becomes smaller. Also, new means of modern transport contribute to this. Certainly, the now-established European Common Market, the forthcoming establishment of the Euro as the European currency and the expansion of the European Union towards Eastern Europe will contribute to a higher mobility of people and information.

Recently, there has been a rapid change in the labour market. This has led to demands for a more flexible labour force, with increased short-term, part-time and casual working. There is increasing pressure being put on higher education by industry to deliver graduates who are immediately employable and effective in business and industry [4]. Graduates are required that are successful problem solvers, showing the ability to work flexibly within constantly changing problem situations [5]. Employers' organizations have pointed to an insufficient match between the outcomes of study programmes and labour-market needs [6]. If vocational and academic education systems are required to supply graduates

who can be utilized immediately and flexibly within the labour force, this implies a growing need for assessment procedures for the relevant skills [7]. Educational measurement specialists [8,9] have recognized that, in the near future, effective and efficient systems for performance assessment and other forms aiming to assess different aspects of students' competencies will have to be developed.

Free-market ideology and strategies have recently entered the world of education. More and more initiatives are being taken at governmental levels to promote a more demand-driven approach to education, aiming to balance the demands from industry and the preferences of students. Institutes of higher education are increasingly having to compete with each other to recruit students, and as a result the needs and wishes of students are receiving more attention, thus placing students in the role of consumers [10]. It is evident that the possibilities of ICT will enhance this development.

An increasing need for lifelong learning in modern society [11] will enhance the need for learning throughout one's entire working life [12]. In the last decade, there has been an increasing focus on training in industry and business. Economic pressures requiring major restructuring in the labour market were major factors leading government and employers to emphasize the importance of adaptability within the labour force and the ability of employees to acquire new skills throughout their working lives. It is widely accepted that the need for lifelong learning will increase even more rapidly in the near future [4].

Given the current demands, we should develop more powerful learning environments, which encompass both instruction and assessment. Therefore, an appropriate instructional and assessment approach is needed [13].

Traditional instruction and the testing culture

The traditional instructional approach viewed learners as passive recipients of information. Memorization of the content, narrated by the teacher, was the main goal of the instructional process. The deposited knowledge was merely abstracted. Learning and teaching were individual processes with the individual teacher in front of the audience, a collection of individual students [14,15].

The assessment approach that accompanied this teaching approach concentrated mainly on the testing of basic knowledge, supposedly acquired through drill and practice experiences, rehearsals and repetitions of what was taught in class or in the textbook. During the past three decades, the development of tests for accountability purposes, as well as their scoring and interpretation, was dominated by measurement experts using sophisticated psychometric models. In the Western world, especially in the United States, their work was guided by the demand for objectivity and fairness, requiring a high level of standardization because of the high stakes attributed to test scores. Under such circumstances, tests, mainly of the choice-response format, such as multiple-choice, true/false or matching items, were the common tools for assessment [8]. This assessment system is sometimes referred to as a 'testing culture' [16,17]. It has the following characteristics: (i) instruction and assessment are considered as separate activities, the former being the responsibility of the teacher and the latter the responsibility

of the measurement expert; (ii) the test plan, the writing of each test item, the development of criteria for evaluating test performance and the scoring process are not usually shared with the students and remain a mystery to them; (iii) the items/tasks are often synthetic, in as much as they are unrelated to the student's life experience; (iv) the majority of test items are of the choice format, examining knowledge of decontextualized, discrete units of the subject matter; and (v) the tests are usually of the paper-and-pencil type, administered in class under time constraints and forbidding the use of helping materials and tools.

In other words, the first draft of the student's work produced under stressful conditions and within unrealistic constraints is often used for determining high-stake consequences. Also, what is being evaluated is merely the product, with no regard to the process, and the results usually take the form of a single total score [8].

These instruments have received a lot of criticism [8,17–22]: traditional tests do not resemble actual learning tasks; also, tests don't seem to tap the actual conduct of problem solving. High on the list of conventional testing practices is the focus on the easily quantifiable rather than messy and complex displays of skills and knowledge. Another criticism concerns the influence of testing practices on the instructional process. Traditional tests tend to narrow the learning process to consumption of knowledge provided by the teacher (i.e. the traditional instructional approach) [14].

The current instructional approach and the assessment culture

For many years, the main goal of academic education has been to make students knowledgeable within a certain domain. Building a basic knowledge store was the core issue. Recent developments in society have changed these goals. Emphasis is now on producing highly knowledgeable individuals as well as individuals with problem-solving and professional skills.

The main goal of higher education has moved towards supporting students to develop into 'reflective practitioners' who are able to reflect critically upon their own professional practice [23–25]. Students taking up positions in modern organizations need to be able to analyse information, to improve their problem-solving skills and communication and to reflect on their own role in the learning process. Increasingly people have to be able to acquire knowledge independently and to use this body of organized knowledge to solve unforeseen problems [12, 25a]. In line with these changing goals in academic education and as opposed to the traditional approach, the current teaching and assessment conception stresses the importance of the acquisition of specific cognitive, metacognitive and social competencies [26, 26a]. Birenbaum ([8], p. 4) states:

> *"…successful functioning in this era demands an adaptable, thinking, autonomous person, who is a self-regulated learner, capable of communicating and co-operating with others. The specific competencies that are required of such a person include*

- *cognitive competencies such as problem solving, critical thinking, formulating questions, searching for relevant information, making informed judgements, efficient use of information, conducting observations, investigations, inventing and creating new things, analysing data, presenting data communicatively, oral and written expression;*
  - *meta-cognitive competencies such as self-reflection and self-evaluation;*
  - *social competencies such as leading discussions and conversations, persuading, co-operating, working in groups etc. and affective dispositions such as for instance perseverance, internal motivation, responsibility, self-efficacy, independence, flexibility, or coping with frustrating situations."*

To reach these goals, Koschmann et al. [27] describe six principles for effective learning and teaching.

- The principle of multiplicity: learning is the acquisition of knowledge that is in nature complex, dynamic, contextual and consisting of a network of interrelated elements.
- The principle of activeness: learning is an active and constructive process.
- The principle of accommodation and adaptation: learning is a process of acquiring information and transforming it into knowledge by linking it to and inserting it into the existing knowledge networks.
- The principle of authenticity: learning is determined by the learners' individual goals and the context in which the learning takes place.
- The principle of articulation: learning is enhanced by the formulation and abstraction of acquired knowledge.
- The principle of termlessness: learning is the acquisition of knowledge in evolution, in continuous change.

De Corte [28] added a seventh principle, the principle of co-operation: learning is more effective in a social context.

These principles are the basis for the design of many so-called powerful learning environments. A powerful learning environment is characterized by a good balance between discovery learning and personal exploration on the one hand, and systematic instruction and guidance on the other. To an important extent, the student is responsible for his own learning. The teacher is the initiator and the guide of this process who becomes a mentor or a coach, providing opportunities for the learners to use what they already know to understand new topics. The teacher is expected to provide interesting and challenging tasks that are related to the learner's experience and can improve his/her learning strategies and understanding [8]. Another important characteristic of powerful learning environments is the necessity to anchor learning in real life situations and contexts [15,26]. Research outcomes [29,30] support the conclusion that students' constructive learning activities should preferably be embedded in contexts that are rich in resources and learning materials, that offer ample opportunities for social

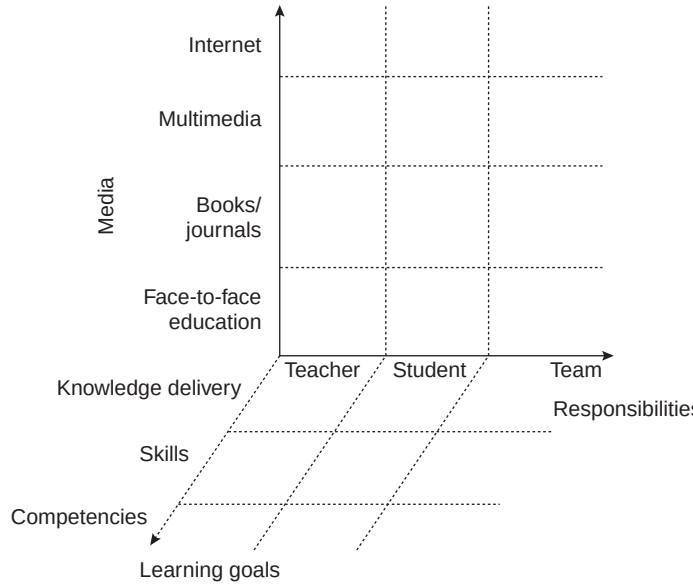
interaction and that are representative of the kinds of task and problem to which the learners will have to apply their knowledge and skills in the future.

The changing goals, the new methods of instruction as well as the new findings and insights in powerful learning environments point to the necessity of reconceptualizing current tests and assessments and of examining critically their underlying theory [31,32].

Learning and assessment need to be in harmony. Research has shown that the nature of assessment tasks influences the approaches that students adopt to learning. Traditional assessment approaches can have effects contrary to those desired [33]. Segers [34] gives a second reason why instruction and assessment must be linked. Student outcomes provide information that can be used to improve educational practice and to improve a student's individual learning only when the instruments that measure the outcomes match the instructional practices. Because of their static and product-oriented nature, traditional achievement tests fail to provide relevant diagnostic information that is needed to adapt instruction appropriately to the needs of the learner [35–37]. Tests that are inadequately linked to instruction lead to undesirable consequences such as inappropriate information about learning progress and learning difficulties, reduction of student motivation for learning, and incorrect evaluation of the effectiveness of instruction.

Linking recent insights in learning and instruction to assessment has led to the assessment approach, sometimes called an 'assessment culture' [16,17]. This culture has the following characteristics. There is a strong emphasis on the integration of assessment and instruction. Most assessment experts like Birenbaum [8], Nitko [38] and Keeves [39] take the position that appropriately used educational assessments can be seen as tools that enhance the instructional process. There is strong support for representing assessment as a tool for learning. The view that the assessment of students' achievements is something which happens solely at the end of the learning process is no longer tenable [15]. The position of the student is that of an active participant who shares responsibility in the process, practices self-evaluation, reflection and collaboration, and conducts a continuous dialogue with the teacher. Students participate in the development of the criteria and the standards for evaluating their performance. Both the product and process are being assessed, and the assessment takes many forms, all of which are generally referred to by psychometricians as "unstandardized assessments embedded in instruction" [40]. Usually there is no time pressure, and a variety of tools that are used in real life for performing similar tasks are permitted. The tasks are often interesting, meaningful, authentic, challenging and engaging, involving investigations of various kinds. Students document their reflections in a journal and use portfolios to keep track of their academic and vocational growth. Finally, reporting practices shift from a single score to a profile, i.e. from quantification to a portrayal [8].

Figure 1



The design of a learning environment on three axes: media, learning goals and responsibilities

Modified from [41], with permission.

ICT and new insights in learning and assessment

What role can ICT play in the recent developments, such as the design of a powerful learning environment with an assessment culture? Figure 1 incorporates the developments within the use of media in learning environments, the shift in responsibilities and in goals of education [41]. This Figure shows that there are 36 possible designs for a learning environment, combining learning goals, media and responsibilities for learning. It is clear from the above discussion that developments aim towards learning in teams, professional competency as a final goal (stressing the importance of knowledge, skills as well as professional attitudes) and the use of Internet applications to serve different functions within the learning process. Gilbert [42] refers to the term 'connected education': the use of IT to connect students and teachers better to information, ideas and each other.

Van Tartwijk [42a] distinguishes between three categories of learning activity in which ICT can play a supporting role: (i) communicating; e-mail, discussion lists, computer conferencing; (ii) working on learning tasks; programmes for online testing, groupware, websites of online courses; and (iii) acquiring information; electronic databases, databases on the Internet, digital learning materials.

For assessment, ICT offers a set of possibilities, enhancing the implementation of an assessment culture. It enhances the implementation of the following principles. (i) Flexibility, which means no time, place or task restrictions [43]. Students can take part in formative as well as summative assessment

procedures where and when they decide it is appropriate and on the basis of a variety of assessment tasks. (ii) Assessment as a tool for learning. The students have online, i.e. continuous, possibilities to diagnose their competencies. Additionally, most test-serving systems offer profound feedback. Students' progress is also available online. In this way, the integration of assessment within learning is enhanced. (iii) Responsibility of students for their learning. Flexibility is one condition for giving more responsibility to the learner. A second condition is sharing responsibility in the process of assessment. The use of electronic peer assessment and electronic portfolios are examples of electronic assessment methods that are in line with this principle. (iv) Product and process assessment. In most electronic portfolios as well as electronic peer-assessment systems, product and process criteria are used. (v) A variety of assessment instruments. ICT enhances the permanent availability of a set of different assessment instruments, from measuring knowledge reproduction by standardized tests to the assessment of skills by electronic portfolios or peer-assessment systems. (vi) Authenticity of assessment. Real-life cases, electronic simulation games etc. are available online, which makes it feasible to assess different aspects of students' competencies in an authentic way. (vii) The student as an active participant in the assessment process. One aspect is the students' responsibility to develop in the criteria for assessment through interaction and discussion with teachers. Electronic peer assessment is one example. A second aspect is the use of assessment tasks that ask students to actively construct a solution to the task. Examples are electronic, often online, simulations and electronic case-based assessment instruments.

As is clear from these seven principles, ICT can support the different functions of assessment. First, it enhances the feedback function of assessment for teachers as well as for students. Second, it makes summative assessment on the basis of students' individual goals and competencies (adaptive testing) more feasible.

ICT within assessment can itself serve different functions [44]. It can be used as a tool to enhance the efficiency of assessment practices. Examples are the use of spreadsheet programs, statistical packages, test-serving systems, e-mail to communicate about assessment (e.g. procedures, test results) etc. ICT can also make accessible tasks that are the basis of assessment, and other information that is necessary to fulfil the assessment tasks. Examples are simulations, real-life cases and electronic databases (see the OverAll Test, below). The next section describes a set of assessment forms that use the seven principles and the functions described above.

ICT and new assessment forms

A research project initiated by the Dutch Ministry of Economic Affairs and part of the national programme 'Electronic Highway' discusses the future themes and developments of ICT in education. In the near future it will be stressed that the use of the worldwide web needs to support the active participation of students in the learning process, as opposed to just the delivery and presentation of

information. Recent developments in the use of ICT within assessment practices are in line with this statement.

During the last decade, the use of a set of so-called new assessment forms has increased dramatically. Examples are authentic performance tasks, simulations, reflective journals, group projects, interviews, self-, peer and co-assessment, electronic presentations, two-stage assessments, short reports, portfolios and assessment centres. Although some of these methods have earlier been used as instructional methods, it is only recently that they have been used as tools for assessment. Below we will present recent assessment forms and describe the function of ICT. We will elaborate on three assessment forms: self-, peer and co-assessment, the OverAll Test and portfolios.

Self-, peer and co-assessment

Peer assessment is a process whereby groups of students assess their peers on the basis of mutually agreed criteria. Self-assessment refers to the assessment of students' competency by themselves. Co-assessment indicates that the assessment is a shared responsibility between the teacher and the students.

Self-, peer and co-assessment are used for assessing products of learning such as reports, presentations, reflective journals, designs etc. These assessment forms are also used on the process level. Assessment of a team working on a product, working in a project team or discussing in a tutorial group within a problem-based learning environment are examples of process assessment. Finally, peer assessment is often used to correct a group score for a product on the basis of an individual contribution.

Dochy et al. [12] discuss eight positive effects of self-, peer and co-assessment: increased student confidence in the ability to perform; increased awareness of the quality of the students' own work; increased student reflections

Table 1

Student	PA total score	PA factor score	PA factor	Individual score
Ian	69	9.9	1.2	13
John	69	9.9	1.2	13
Neville	59	8.4	1.1	12
Nigel	45	6.4	0.8	9
Philip	62	8.9	1.1	12
Kathleen	53	7.6	0.9	10
Warren	63	9.0	1.1	12
Paul	55	7.9	1.0	11
Geoff	76	10.9	1.4	15

PA total score = sum − highest − lowest
PA factor score = PA total score/(n − 2)
PA factor = PA factor score/(number of criteria × mean)
Individual score = group score × PA factor
Group score = 11 (= score on the group product)

An example of a peer-assessment (PA) feedback form from the peer-assessment program of Dochy et al. [12]

on their own behaviour and/or performance; increased quality of learning output; higher levels of thinking; greater responsibility taken for their own learning; increased student satisfaction; and an ameliorated learning climate with open communication and more-motivated students.

Within the self-, peer and co- assessment practices, ICT is used in different ways. First, an increasing number of products are presented and available electronically. Second, more and more ICT is introduced as a tool for enhancing co-operative learning. Examples are desktop audio- and video-conferencing systems and the computer-supported collaborative learning environments (CSCLs) [45–47]. This implies that self-, peer and co-assessment are used for assessing co-operation in virtual settings. Third, ICT can be used to support test administration, analysis and reporting of the scores. One example is peer review by e-mail for reporting the scores and discussion lists for setting the criteria. There are spreadsheet programs that support the application of self-, peer and co-assessment. As an example, Table 1 shows a page of a spreadsheet program for peer assessment where the peer score is used as a correction for the group score for a product. There are also examples of self-assessment websites and electronic feedback procedures.

The OverAll Test

The OverAll test was developed at the School of Economics and Business Administration, Maastricht, The Netherlands, and has been implemented in various Dutch schools. The OverAll Test asks students to define, analyse, solve and evaluate authentic professional problems. The test can be described by a set of characteristics [26]:

- it is part of the final examination. Besides the OverAll Test, it consists of knowledge tests, skills tests and evaluations of student's participation by co-assessment;
- the OverAll Test presents a set of authentic cases which are novel to the students;
- the test items require from the students that they identify, analyse, solve and evaluate the problems underlying the cases;

Figure 2

Mexx/Benneton case

The case presents the history and developments in the fashion companies Mexx and Benneton. Information is available on the organizational structure, product profile, business system, corporate culture and actual facts and figures. The case is new to students.

OverAll test questions

1.°°Mexx s corporate culture and philosophy is consistent with the systems viewpoint on management.
True/?/False

2.°°Identify the two main differences in corporate strategies between Mexx and Benneton. Illustrate your answer with examples from the case.

3.°°What are the advantages of Benneton s corporate strategy to Mexx s approach?

An example of OverAll Test items

- the cases are multidisciplinary;
- the OverAll Test has an open-book character;
- the test items refer to approximately seven different cases.

Figure 2 presents an example of an OverAll Test item. There are several positive effects of the OverAll Test [26]. For instance, the OverAll Test directs the learning of the students towards higher levels of thinking. Tackling complex professional problems is a fundamental competency in recent and future professional life. It makes learning and assessment more authentic. This assessment method requires students to use cognitive competencies similar to those necessary in professional life. It gives students insight into their strengths and weaknesses in problem-solving skills.

Besides possibilities of electronic administration of the OverAll Test, ICT makes it possible to enhance the authenticity of the cases used. Different kinds of case, of real-life data and of databases are available electronically or on the worldwide web. Examples include minutes of meetings, financial reports of firms, reports of an organization, databases of social services, video material from meetings, advertisements for a specific product, interviews etc.

Portfolios

In the past, various professions have used portfolios to demonstrate competence, but it is only recently that portfolios have been introduced as educational assessment devices [48–51]. Arter and Spandel ([48], p. 36) define portfolio assessment as follows: "A purposeful collection of student work that tells the story of the student's efforts, progress or achievement in (a) given area(s). This collection must include student participation in the selection of portfolio-content; the guidelines for selection; the criteria for judging merit; and evidence of self-reflection". It is used for a longitudinal assessment of processes and products.

There are different forms of portfolio. (i) Exemplary portfolio: a collection of the best and most representative examples of a students' work or products, produced over a long period (e.g. 2 years of study). (ii) Process or holistic portfolio: consists of examples of the student's development, their progress and a report of the progress. (iii) Combined portfolio: a combination of both former forms of portfolio, including the student's step-by-step progress and products. (iv) Product portfolio: consists only of the student's products and can therefore not be a stand-alone assessment instrument [2].

The positive effects of a portfolio are that a portfolio is 'a tool for learning' that integrates instruction and assessment. The learning skills and strategies that students will develop for using their portfolio (data searching, data organizing, interpreting, reflecting) are fundamental competencies in the lifelong learning idea [52,53]. Portfolios are dynamic and interactive. They advance the dialogue and co-operation between the students and the teacher, in which the two collaborate in assessing the student's accomplishments and developments with respect to the subject matter. The production of a portfolio encourages students to participate in and take responsibility for their learning [8]. A portfolio provides a method for portraying the student as a learner, pointing out his or her strengths and weaknesses. It gives insight into the prior knowledge of the student, through

which assessment can be linked with this knowledge [25a]. Portfolios are longitudinal, as they give insight into students' progress in professional competencies Finally, portfolios are authentic instruments in the sense that they include the use of authentic performance tasks, critical self-reports etc. These assessment methods require students to use cognitive competencies similar to those necessary in professional life.

With the growing interest in the use of the portfolio as a tool for learning and as part of assessment practices, different electronic applications have been developed. Barett ([54], p. 1) describes an electronic portfolio as something that "uses multimedia technology allowing students/teachers to collect and organize portfolio artefacts in many media types (audio, video, graphics, text) with hypermedia links connecting that evidence to the appropriate standards. Students/teachers can publish their Electronic Portfolios on CD-Recordable discs, video tape or the Internet." There are a lot of technologies available that can be used to store and publish digital portfolios, including generic construction tools and commercial portfolio software packages (see http://transition.alaska.edu/www/portfolios.html).

There are a number of reasons for choosing digital portfolios [54,55]. First, they make it possible to organize the portfolio contents in a clear, comprehensive way, and allow easy navigation from one part to another. Second, with the use of hyperlinks, students themselves can show the relationship between different parts of the portfolio (e.g. standards and portfolio artefacts), demonstrating coherence in their individual learning programme and progress in their competencies. Third, through placing the portfolio on an intranet or the

Figure 3

An example of a digital portfolio from the Amsterdam Faculty of Education (http://onderwijs.efa.nl). *Reproduced with permission from the Amsterdam Faculty of Education, Amsterdam, The Netherlands.*

Internet, it becomes a flexible and efficient means of communication between teachers and students and among students themselves. Finally, portfolios make performances replayable and reviewable.

In Figure 3 an example of a digital portfolio for teacher education is shown. For the portfolio shown, there are some obligatory elements in the portfolio the students have to work on: the opening page, i.e. a short introduction by the student; a curriculum vitae; the products, i.e. all the products made with a justification and a contract, where the individual learning goals are formulated; the competencies, i.e. all competencies relating to the teaching profession; presentations, i.e. an archive of products and a selection of the products that the student wants to be represented by; and overviews, i.e. the student creates their own overviews, such as an overview of learning practices and their assessments.

Conclusions

Developments in the learning environment and in the assessment culture stress the change in the main goal of learning from 'knowing a lot' to 'being able to use knowledge and skills to tackle problems'. The emergence of so-called competency-based education and the so-called powerful learning environments are examples of this shift in thinking. In order to reach this goal, the explicit objective for the design of the powerful learning environment is to interweave assessment and instruction. New assessment forms such as self-, peer and co-assessment and portfolios are implemented increasingly in schools. Although the results of research on the implementation of the 'new assessment culture' are promising, the use of new assessment procedures as a tool for learning has not been entirely positive. Madaus and Kellaghan [56] refer to problems with the organization, time and costs of authentic assessment programmes. Birenbaum [8] advocates that different assessment instruments serve different purposes and therefore we should introduce balanced or pluralistic assessment programmes. Additionally, Messick [57] indicates that each assessment form has its own method variance, which interacts with persons (the assessors and the students assessed).

Concerning the use of ICT in education, in accordance with the recent insights in effective learning, there is a growing interest in the development and implementation of CSCLs. Lehtinen et al. [58] have reviewed the research on the effects of CSCL. They concluded that, because of weak research designs and the absence of clear empirical data, up until now only few research projects have been able to answer the question of the added value of computers and networks in CSCL environments in comparison with co-operative learning environments without technology. There is even less evidence about the effect of the ICT within assessment practices. There is clear growth in the use of IT in assessment for different purposes, such as administrative support (test-service systems), a tool to support communication between teachers and students, a tool for feedback, and flexible and easy access to databases and other sources of information. Whether ICT can fulfill these purposes and enhance the integration of learning and assessment, and in what sense and under which conditions, is on the agenda for future research.

Research has been done on the way ICT is used in higher education [43]. The results indicate that recent ICT applications stress the active participation of students and co-operation between students. Websites are used to search for and study information as well as to exchange information. Webboard and Webconference are examples of applications used increasingly in education. It is concluded by Collis and van der Wende [43] that the effectiveness, efficiency and flexibility of learning is enhanced by the use of IT. This conclusion is based on indications such as students' increased satisfaction with education. One of their final remarks implies a challenge for future developments and research. It is stated that up until now there is no empirical evidence that developments in IT have produced students that are more competent. This remark raises new questions. In summarizing the challenges facing us in the near future, we propose three main themes.

First, although there is an increasing amount of research and literature, there are still many questions about the quality of the new assessment instrument. Various authors have recently proposed ways to extend the quality criteria, techniques and methods used in traditional psychometrics [53]. Second, in only a few cases is there systematic implementation of applications. Mostly, ICT is used individually or for certain projects. Different kinds of application are often used for different purposes within one department without a shared view on learning, instruction and ICT. The use of ICT in powerful learning environments is in most cases still a matter of pioneering. Systematic implementation of ICT in these learning environments is an important condition for starting empirical research projects. Third, pressure that IT puts on time and task loads for teachers as well as staff members is in most cases perceived to be high [43]. Green ([3], p. 2) states that "for many institutions user support and instructional integration are the flip side of the same coin, complementary components of the broad challenge that involves the effective use of new technologies in teaching, learning, and scholarship". Training of staff members in the integration of ICT in the learning environment will be high on the agenda of most schools. Fourth, the research methods and frameworks for investigating the effects of ICT on learning are still in development [59,60]. Research is done to look for methods and frameworks for the search of the effect of CSCL on the depth of group discussions [59]. These four developments are essential conditions for setting up empirical research into the effects of ICT on learning and assessment.

It is clear that the train that is ICT in education is a high-speed train, passing through the tunnel of powerful learning environments. The end of this tunnel is still not in sight. There are different railway stations to stop at, to reflect on and even at which to undertake action. As an increasing number of people are working on the construction of this railway system and experience is growing fast, the future looks promising.

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